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A. C. TRUE, DIRECTOR.

Experiment Station Work.

Vol. IV, No. 1.

Compiled from the Publications of the Agricultural Experiment Stations.

UNUSUAL *v.* STANDARD FERTILIZERS.
SYMPTOMS OF DISEASE IN PLANTS.
PREMATURE DROPPING OF FIGS.
CONDIMENTAL FEEDS.
FEEDING THE DAIRY CALF.
DEFECTS IN COTTAGE CHEESE.
THE IOWA SILO.

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EXPERIMENT STATION WORK.

Edited by W. H. BEAL and the Staff of the Experiment Station Record.

Experiment Station Work is a subseries of brief popular bulletins compiled from the published reports of the agricultural experiment stations and kindred institutions in this and other countries. The chief object of these publications is to disseminate throughout the country information regarding experiments at the different experiment stations, and thus to acquaint farmers in a general way with the progress of agricultural investigation on its practical side. The results herein reported should for the most part be regarded as tentative and suggestive rather than conclusive. Further experiments may modify them, and experience alone can show how far they will be useful in actual practice. The work of the stations must not be depended upon to produce "rules for farming." How to apply the results of experiments to his own conditions will ever remain the problem of the individual farmer.—A. C. TRUE, Director, Office of Experiment Stations.

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ILLUSTRATIONS.

EXPERIMENT STATION WORK.[a]

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UNUSUAL VERSUS STANDARD FERTILIZERS.[b]

John S. Burd, of the California Experiment Station, calls attention to attempts that are made from time to time by means of articles in newspapers and periodicals and by advertising literature to exploit various naturally occurring rocks and mineral deposits as fertilizers, and states that such of these propositions as he has been able to investigate are totally without merit.

It should be borne in mind that few materials have any fertilizing value until refined or otherwise treated with a view especially to making their constituents readily available to plants. "The idea has frequently been advanced that certain common rocks, notably those containing potash feldspar, should be of value as fertilizer because of their content of potash." Although many of these materials are relatively rich in potash it is combined in such insoluble forms that "it is difficult to see how applications of such materials would result in any immediate or important crop increase."

The well known fact that lava rocks have frequently broken up into fertile soils within a very limited period is used as an argument to prove that lavas should make a good fertilizer. This, however, does not follow. A mineral fertilizer to be worth the cost of application should contain relatively large amounts of one or more of the so-called "plant foods" in a comparatively easily soluble condition. To furnish an amount of actual potash equivalent to that in an ordinary application of sulphate of potash would require a relatively enormous quantity of ground lava of average composition. In addition the condition in which potash, the essential constituent, is combined with the other rock constituents is such as to justify little hope of its being utilized by plants within a reasonable period of time. Potash insoluble in water, as it occurs in such materials, has no standing among reputable agriculturists.

In brief, if these unusual materials have any agricultural value at all it is likely to be only under exceptional conditions, and therefore the average farmer will find it safest to depend upon the standard, well-known sources of supply for his fertilizing materials. These are subject to state inspection, which affords a guaranty of composition and protection to the purchaser.

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[a] A progress record of experimental inquiries, published without assumption of responsibility by the Department for the correctness of the facts and conclusions reported by the stations.

[b] Compiled from California Sta. Circ. 56.

SYMPTOMS OF DISEASE IN PLANTS.[a]

It is highly important that farmers and horticulturists should be able to recognize plant diseases. Many fail to do this because they do not know the general symptoms that indicate the attacks of insect or fungus enemies.

Plant diseases may be divided into three groups: (1) Nutrition disturbances due to unfavorable conditions in the environment of the plant or inherent in the plant itself; (2) troubles due to parasitic plants, usually either bacteria or fungi, but sometimes to flowering plants, which deform, stunt, or kill the plant; and (3) insect pests, which are in many cases very evident but often not easily detected.

The first step of importance to the farmer is to be able to determine the presence of disease and to endeavor to find out its cause, nature, and probable outcome, and the treatment which should be employed. The principal symptoms of disease in plants are the following: (1) Discoloration, or change of color from (*a*) normal green to a yellow or white pallor; (*b*) colored spots or areas, as white or gray on leaves or stems, such as mildews or white rusts, many leaf spots of yellow, red, orange, brown, black, or variegated colors, red or orange rusts, black rusts, tar spots, and the like; (2) shot-hole perforation of leaves; (3) wilting, such as damping off or wilt; (4) necrosis, such as death of parts of plants, leaves, twigs, stems, or flowers; (5) reduction in size, such as dwarfing or atrophy; (6) increase in size, such as hypertrophy; (7) replacement of organs by new structures; (8) mummification; (9) change of position; (10) destruction of organs; (11) excrescences and malformations, such as pustules, tumors, corky outgrowths or crown galls, cankers from malformations in the bark generally resulting in an open wound, punks, or conches and other fruits of fleshy fungi, witches' brooms, rosettes, and hairy root; (12) exudations, such as slime flux, gummosis (especially for stone fruits), and resinosis (especially for coniferous trees); and (13) rotting, such as dry and soft rots, root rots of alfalfa, cotton, beets, or cherries (generally of fleshy or woody roots), stem or trunk rot, such as dry rot of trees and of modified stems like rhizomes, bulbs, or tubers, and bud and fruit rot of various fleshy fruits.

Soils decidedly alkaline, lacking in proper drainage, or deficient in iron may produce a yellowing of the foliage, while discoloration of restricted areas on the leaves is usually due to the attacks of some insect or plant parasite, presumably the latter.

In general, any marked variation in color or shape from the normal type is a sure indication of disease which in many cases may be controlled and the crop saved if taken in hand promptly.

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[a] Compiled from Vermont Sta. Buls. 142 and 147; Bul. Univ. Texas, Sci. Ser. No. 14.

THE PREMATURE DROPPING OF FIGS IN THE SOUTH.[a]

In a recent bulletin on fig culture F. C. Reimer of the North Carolina Station calls attention to the wholesale premature dropping of the crop which occurs annually with many fig trees in that State and in other States as well.

There are many fig trees in this State which would produce several bushels of fruit every season if it could grow to maturity; but when about two-thirds grown the fruit turns yellowish, begins to shrivel, becomes dry and tough, and then drops. With the first crop it all drops within a few days; while with the second the dropping extends over a long period, each fruit falling as soon as it reaches a certain size or stage of maturity.

This trouble has been attributed to various causes such as adverse weather conditions, too rapid growth, poor soil, and lack of proper fertilization. After examining specimens of fruit received from various sections of the State, however, together with many others personally collected, Professor Reimer finds that wherever the dropping is at all serious the trouble is due to the kind of fig grown. Fully 95 per cent of the figs examined were true Smyrna seedlings and of no value for culture in the South since the flowers of these seedlings must be fertilized by the flowers of the wild fig or caprifig; otherwise the fruit will shrivel and drop off before maturing. Thus far neither the caprifig nor the fig wasp *Blastophaga grossorum*, which is reared in the caprifig and carries the pollen to the flowers of the Smyrna fig, has been successfully domesticated in this country, except in the warmer sections of California where the Smyrna fig industry is being developed to a considerable extent.[b]

The caprifig rarely produces edible fruit, hence whether the seedlings partake of the nature of the Smyrna fig or of the caprifig they are of no value in the South and, as Professor Reimer recommends, they should be destroyed and replaced with varieties of known value, such as the Brown Turkey or the Celestial, which varieties have thus far proved to be the best in the latitude of North Carolina. Farther south many other excellent varieties can be grown.

A previous bulletin of this series contains considerable detailed information relative to fig growing in the South.[c]

CONDIMENTAL FEEDS.[d]

In a previous bulletin of this series[e] attention was called to experiment station investigations which showed that the value of condimental feeds and condition powders for stock usually found on the

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[a] Compiled from North Carolina Sta. Bul. 208.

[b] There exists, however, according to Dr. L. O. Howard, no doubt that the caprifig and its attendant wasp (*Blastophaga grossorum*) can be successfully propagated in our Southern States.

[c] Experiment Station Work, Vol. III, p. 239.

[d] Compiled from Indiana Sta. Bul. 93; Iowa Sta. Bul. 87; Maine Sta. Rpt. 1896, p. 52; Massachusetts Sta. Bul. 86; Vermont Sta. Bul. 104.

[e] Experiment Station Work, Vol. III, p. 297.

market has been exaggerated. A number of feeding experiments at the state stations since that article was published have furnished additional evidence that these feeds do not produce the wonderful results claimed for them, but when used to any large extent greatly increase the cost of beef, pork, and milk production because of the exorbitant prices at which many of them are sold. Some of these feeds sell for \$200 to \$300 per ton, but contain material actually worth only \$20 to \$45 per ton.

If farmers wish to give condiments or tonics to their stock, it would be much cheaper to buy the ingredients commonly used and do their own mixing. The following formula for a condimental feed, recommended by the Vermont and Maine stations, can be prepared for about 20 cents per pound, and is much cheaper and better than many of those commonly sold: Ground gentian 1 pound, ground ginger ½ pound, powdered saltpeter ½ pound, powdered iron sulphate ½ pound; mix and give 1 tablespoonful in the feed once daily for ten days; omit for three days, and feed as above for ten days more.

The Iowa Experiment Station suggests the following: Fenugreek 8 pounds, ginger 8 pounds, powdered gentian 8 pounds, powdered sulphur 8 pounds, potassium nitrate 8 pounds, resin 8 pounds, cayenne pepper 4 pounds, flax meal 44 pounds, powdered charcoal 20 pounds, common salt 20 pounds, wheat bran 100 pounds. This mixture costs less than \$5 per 100 pounds and very nearly approximates the composition of the average condimental feed. However, the farmer must realize that—

> A tablespoonful of such a mixture fed night and morning would not put his stock on the market in thirty days less time, neither would it double the flow of the milk of his dairy herd, nor would it prevent cholera in hogs, abortion in cattle, roup in chickens, or glanders in horses. It is yet to be proved that any stock food or tonic will do this. The feeding of domestic animals is and always will be a matter of applied common sense and intelligence. But such a stock food would have the merit of being extremely inexpensive, besides having as much merit in other ways as any of its class.

FEEDING THE DAIRY CALF.[a]

An article in a previous bulletin of this series[b] dealt particularly with substitutes for whole milk in calf feeding. It is the purpose of this article to present a brief review of the whole subject by D. H. Otis, of the Wisconsin Experiment Station. In the first place Professor Otis calls attention to the herdsman's responsibility in feeding and caring for the dairy calf. If the dams have been properly nourished the value of the calves at birth depends largely, if not entirely, upon the intelligence and skill exercised by the owner in their breeding.

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[a] Compiled from Wisconsin Sta. Bul. 192.
[b] Experiment Station Work, Vol. III, p. 374.

The future possibilities of the newborn calf, however, rest on the thought and skill that the owner puts into its feed, care, and management. Mistakes at this period of the calf's life are probably of lifelong influence, while a mistake in feeding and caring for a mature animal may be only temporary in its effects. Calf feeding requires skill and good common sense, as there are no hard and fast rules that can be laid down.

Young calves need whole milk for the first few days. The calf should always have the first or colostrum milk of the cow and be allowed to nurse the cow until the eighth or ninth milking, when the milk is suitable for human food. Feed often with small amounts to avoid overfeeding. Teach the calf to drink and feed whole milk for at least three weeks, changing to a skim milk diet gradually.

By good feed and care, or the lack of it, it is easy to make a variation of $1 to $5 or even $10 per head in the value of tho calf the first year.

Skim milk is a cheap food for calves but should be fed carefully in limited quantities and only while it is warm and sweet. Skim milk may form the principal diet of the calf for eight months or a year. Factory skim milk should always be pasteurized to avoid the spread of tuberculosis. The best skim milk is that which is fresh from the separator and still warm. Experiments show that it is only one-fourth as expensive to raise a calf on skim milk as whole milk. Two pounds grain with the proper amount of skim milk equals one pound of butter fat. Buttermilk or whey may profitably be fed to calves.

Milk that is too rich may cause serious trouble from scours, and in feeding such milk care should be exercised to give limited amounts at tho proper temperature. The feeding of whole milk should be continued for about three or four weeks, when the number of meals may be reduced to two per day. From one-half to a pint of skim milk may now be substituted for an equal quantity of whole milk. The amount of skim milk may be gradually increased and the amount of whole milk correspondingly decreased until, at the end of a week or ten days, the calf is getting all skim milk. Feed the milk sweet and at blood temperature.

Not over 10 to 12 pounds of milk daily should be fed until the calf is 5 to 7 weeks old. Later the amount may be increased to 14 or 16 pounds and at three months may, though not always, go to about 20 pounds. The amount fed, however, must be carefully regulated by the ability of the calf to handle it without scouring.

The grain for calvos should be fed first while the calf is quite small with a little bran to aid the calf in learning to eat. High-priced concentrates are unnecessary and give no better results than corn meal, oats and bran, ground barloy, etc., when fed in proper combinations. At four to six weeks a calf has good teeth and can grind his own feed. A variety of feeds is advantageous and best results will usually be secured from mixtures.

The roughage for calves should first be fed at two or three weeks of age when the calf begins to eat grain. Good clean hay, either timothy, blue grass, clover, or alfalfa may be used. Corn silage is an excellent calf feed when fed in moderate amounts. Good pasture is an essential after four to six months of age, and if the calf is turned out for only a few hours each day at first scours will be avoided.

Whey has the casein as well as the butter fat removed and hence is a much less valuable feed than skim milk; a good grain ration must be carefully selected as a supplementary feed. The calf to be fed on whey should receive whole milk for the first week or two; it can then be changed to skim milk. If this is not available it should be continued on whole milk. A calf will do better not to receive whey for five to six weeks. It will take ten days to two weeks more to complete the change to

whoy. Calves will handlo about the same amount of whey as skim milk, viz, 14 to 16 pounds daily per calf. An excessive amount may causo undue largeness of the paunch. The feeder will need to give more care and attention to calves fed on whoy than to those fed milk.

Calves, like other farm animals, get thirsty, oven though milk forms a large part of thoir ration. Calves three months of age will drink as much as 5 quarts of water daily per head. They like to drink often, sipping a little at a time. A half barrel, cleaned and replonished twice daily, will serve nicely as a water trough. Another good device is an automatic waterer, which may he easily cleaned, situated a little above the floor to keep out the litter. Salt is essential to the development of the calf, as of other animals, and should be kept continually available.

The management of tho calf during the first year has much to do with its later usefulness. Plenty of water and salt should be given in clean vessels. Avoid sudden changes of diet and practice regularity in feeding. Provide warm, dry quarters in damp weathor. Give plenty of roughage and not too much grain so as to develop a large capacity for handling food as is desirable in dairy animals. When the calf is six months to a year old milk may be omitted from its ration and a full roughage and grain diet substituted.

When the skim milk diet is stopped at any time from 6 to 12 months of age, it should be romombered that the calf is deprived of a nitrogenous feed and its place should bo taken by some nitrogenous grain or roughage. The tendency of the dairy calf to get too fat depends not only upon its temperament but also upon its feed. Avoid too much corn. For grain, oats and barley aro good; for roughage, bright clover or alfalfa hay with corn silage to give succulence and variety.

Size depends much upon heredity but even more upon liberal and judicious feeding. It is impossible to starvo good dairy qualities into a growing heifer but many a promising heifer has been starved into a poor cow.

The intelligence that the herdsman puts into his calf feeding will have a great influence upon the futuro cow. There are great possibilities in the production of good cows but these are seldom if ever seen, appreciated, or attained except by an intelligont, thoughtful feeder. The earmarks of an intelligent feeder are seen in his hord. Tho calves aro thrifty, activo, with bright eyes, smooth, glossy coats, always hungry, and playful and lusty.

DEFECTS IN COTTAGE CHEESES.[a]

Methods of making cottage cheeses were described in a previous bulletin of this series.[b] The common defects in cottage cheese, and their causes and remedies,[c] are summarized in a bulletin of the New York Cornell Station substantially as follows:

Defects in flavor.—Unclean, bitter, acidy, and food flavors due to bacteria which gain entrance in one or more of the following ways: Unclean milk supply, unclean utensils, on dirt carried by flies, impure starters, development of acid, and to strong-smelling foods which the cows have eaten. It is practically impossible to make the cheese any better than the milk supply. Many undesirable flavors can be avoided, however, by pasteurizing part or all of the skimmed milk and ripening with a good commercial starter.

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[a] Compiled from New York Cornell Sta. Buls. 257, 270.

[b] Experiment Station Work, Vol. II, p. 164.

[c] Seo also U. S. Dept. Agr., Farmers' Bul. 92, p. 25.

Defects in texture.—The most common defects are dry, mealy, and lumpy texture due to too little moisture or an uneven incorporation of moisture in the cheese, as a result of too high or uneven temperature during the manufacturing process, which usually occurs in cold weather in buildings where the temperature can not be controlled, of overdevelopment of acid, too rapid drying or uneven drying, use of too much rennet, or uneven coagulation.

If uniform results are to be obtained tho temperatures and acidity must be uniformly controlled. In cold weather the building should be warm. The use of an acidimeter affords an accurate means of determining the amount of acid at all times, and when this is known tho development can be controlled by raising or lowering the temperature as desired. Lactic acid forms most rapidly at 90° F., and as this temperature is lowered the growth of lactic acid forming bacteria is checked proportionally. An important fact to remember is that tho lower the temperature and still have a proper coagulation the smoother will be the texture.

The cheese is also sometimes soft, pasty, or mushy in texture, due to too much moisture in the cheese resulting from too low temperature of coagulation, imperfect coagulation, or insufficient drying. The precautions given under dry texture apply here as well.

The great secret of successful cottage cheese making lies in the proper controlling of temperature, acidity, and moisture during the entire manufacturing process. A high moisture content means more whey and therefore more milk sugar, and subsequently a greater and more rapid formation of acid. In dry cheese the formation of acid is slower.

All soft cheeses should be wrapped in parchment paper and tinfoil. When the wrapping in parchment paper is omitted the cheese is contaminated with the tin.

The bulletin makes the following suggestions regarding the importance of quality in cheese in general:

The finished cheese can be no better than the milk from which it is made. Every cheese maker should be familiar with the use of the acidimeter and the fermentation test. The cheese factory should be the center of rural dairy education. The maker should be qualified to teach his patrons. If the factory building is neatly painted, if the surroundings are tidy, and if the maker himself has a good appearance, it will be easier to induce the patrons to furnish better milk. It will be of much greater value to the cheesemaker, the patron, and the consumer if in the future more attention is given to the improvement of quality rather than quantity.

THE IOWA SILO.[a]

For several years the Iowa Station has been making a careful study of modern silo construction and of the success and merits of different types of silos. A bulletin, issued first in 1908 and reissued in 1909, treated of types of silos then in use and presented a design of a new type of silo constructed of hollow clay building blocks. A more recent bulletin of this station, by J. B. Davidson and M. L. King, describes in detail the construction, merits, and success of this silo, which has come to be known as the Iowa silo. In

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[a] Compiled from Iowa Sta. Bul. 117.

brief, the materials used in the construction of this silo are rectangular hard-burned (vitrified) hollow clay building blocks (fig. 1), which do not readily absorb water; a rich, water-tight mortar, and a cement wash for the inside of the wall; and enough steel reinforcement (hard black No. 3 or No. 9 steel wire) laid in the mortar joints of the silo to resist a bursting pressure of silage of 30,000 pounds per square inch. The doors, either individual or continuous, are constructed of wood as described later. The roof may be of concrete, wood, metal, or other material.

In constructing the silo it is of great importance to have a foundation sufficiently broad to prevent appreciable settling and deep enough to avoid danger from freezing. A depth of 3½ feet is recommended. If there is any probability of ground water standing about the foundation a tile drain should be laid as shown in figure 3.

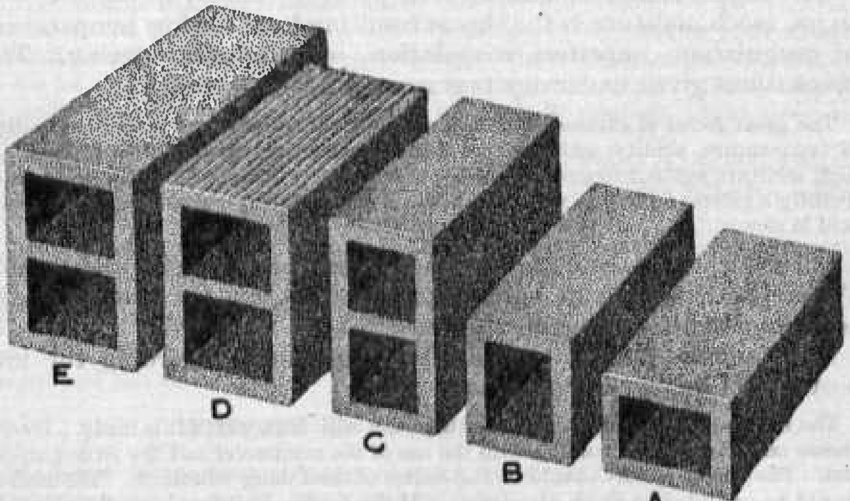

FIG. 1.—Five sizes of hollow vitrified clay building blocks used in silo construction.

"Porous back filling placed outside the foundation insures that any surface or ground water will sink to the drain rather than fill the blocks of the wall through any crevice which may exist."

The foundation may be one of at least four types: "(1) Building blocks throughout; (2) concrete footing with blocks extending from the floor up; (3) concrete footing with blocks laid on end and filled with concrete; (4) concrete footing and foundation extending to about 1 foot above the grade line." In the first type, shown in figure 2—

The first course of the footing is 16 inches wide, made of two 8-inch blocks laid flatwise side by side. Then the next course, 12 inches in width, should consist of blocks laid flat crosswise and bedded in mortar. This completes the footing and the third course becomes the first course of the wall. The third and each succeeding course

should be liberally mortared or plastered at the outside of the vertical joint. This reduces the liability of water getting into any course of the foundation. The lower course if connected to a drain would render any other drainage unnecessary.

[The second type] of foundation simply consists of a concrete footing which is placed in a trench at the bottom of the pit, 12 inches or one spade deep, 8 inches or one spade wide at the top, flared to 16 inches in width at the bottom. On the top of this footing is placed the wall built of blocks. (See fig. 3.)

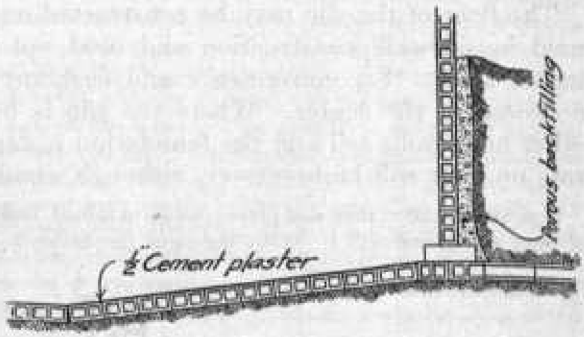

FIG. 2.—Foundation constructed entirely of building blocks.

These two foundations have the advantage of not requiring forms for their construction. The choice between them depends upon their relative cost. When sand and gravel are expensive the first is the cheaper.

Perhaps the greatest objection that can be foreseen to these two forms of foundation is the possibility of the blocks of the wall filling with water, which through carelessness or faulty drainage might be standing against the wall. * * *

In order to prevent any such trouble, the outer joints may be left open at a point directly under the roof down spout, at which point there should of course be special provisions for carrying away all surface water which may collect. This may be easily accomplished by filling over an opening in the drain tile with coarse material, which will always permit the passage of surface water directly and quickly to the drain.

FIG. 3.—Second type of silo foundation.

[The third] type of foundation shown in figure 4 is built with a concrete footing upon which blocks are placed on end, each course being filled with concrete as it is placed and another course placed and filled in a similar manner. This method is continued to a point at least a foot above the grade line. From this point up the blocks are laid horizontally. The advantage of this type is that the possible danger from water is obviated. More expense and work is incurred, although no material for forms is necessary.

[The fourth] type of foundation is shown in figure 5. Earth is utilized for the outer form but lumber is used for the inner. By permitting this to extend down only to

within a few inches of tho bottom of the pit, the footing may be permitted to widen. This is desirable as a wall need never be as thick as the width of the footing. In case tho ground is reasonably level and firm, it will be cheaper to simply dig a narrow trench and widen samo at bottom to 16 inches. If ground is excavated next day and concreto trimmed, a reasonably smooth job is insured.

The floor of the silo may be constructed out of ordinary concrete used in sidewalk construction and need not be more than 3 to 4 inches thick. For convenience and economy it should be slightly hollowed in the center. Where the silo is built on heavy clay or other nonporous soil and the foundation is deep enough to keep out rats no floor will be necessary, although usually a floor is desirable.

If properly graded sand and gravel can be obtained, one part of cement to five parts of sand and gravel will be about the right proportion to uso. Tho concrete should be thoroughly tamped and troweled.

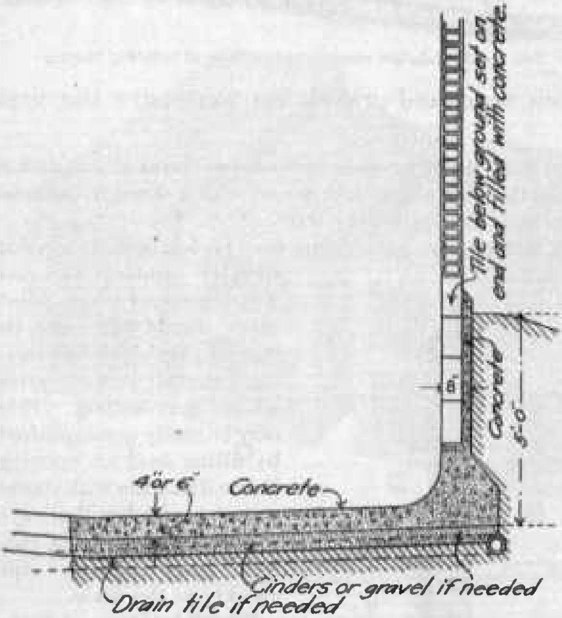

Fig. 4.—Third type of silo foundation.

In some cases where sand and gravel are expensive, it may be cheaper to use a clay sidewalk block or even a hollow block, the same as used in the wall, covered with a thin coat of plaster. In the case of the sidowalk blocks, tho plaster covering would be unnecessary if the blocks wero laid in cement.

There is decided advantage in using curved blocks for the construction of the walls, and such blocks can be made without any great difficulty. "A workman lays up the curved block more rapidly and with more satisfaction than the straight block. The wall is smoother inside and out, which is of obvious advantage to the preservation of silage inside and the appearance outside."

Five different sizes of blocks, as shown in figure 1, may be used, but the type C, in the figure, has many advantages over the other kinds "as it forms a 4-inch wall which is abundantly strong for the purpose and each block forms an 8-inch portion of the wall. With this block less mortar is required than with any other size block." * * *

Also it forms a warmor wall than the smallor size blocks, as there is less material extonding across the wall to conduct heat away from the warm silage. It is also

easier for the mason to handle as he can grip it in one hand conveniently, while a larger block is tiresome to handle. Also in turning a circle with a thicker block, the outer joint stands open proportionately farther. In addition to this, it has the advantage of being more easily bent than a larger block, and costs less as such material is sold by volume. * * *

The mortar used for this work is composed of cement, lime, and sand. The sand should be medium fine. A certain amount of lime is necessary, as cement mortar is not plastic enough to stick to the ends of the blocks when applied. No more lime should be used than necessary to make the mortar workable. The quantity of lime for this purpose will vary somewhat with the material and workman. Perhaps the least amount of lime which could be made to serve the purpose is one part of cement, one-third of one part of lime, and two parts of sand, while one part of cement, one part of lime, and four parts of sand is as much lime as would ever be required and at the same time provides a mortar of good quality. The hydrated lime generally sold in paper sacks is a very convenient form of lime to use, as it can be mixed dry with the cement and sand. Enough may be mixed dry to last one-half day, then wet down as it is needed. The importance of measuring all materials and thoroughly mixing them can not be emphasized too strongly. Thorough mixing is absolutely essential

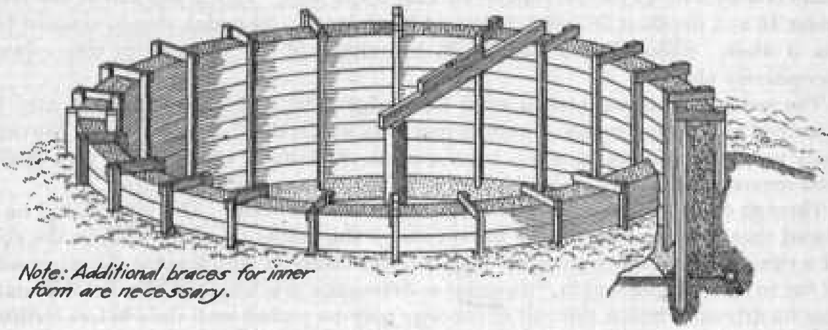

FIG. 5.—Fourth type of silo foundation.

for a smooth mortar. Very few men can make a uniform quality of mortar without measuring the materials.

In order that cement mortar may set properly, it must contain considerable water. If this water is drawn out by coming in contact with hot, dry blocks, the mortar can not harden properly. A hard block will of course absorb less moisture than a soft one, but both hard and soft blocks, if warm, should be dipped for a few moments just before laying.

The most convenient and advantageous place for the reinforcement in this type of a silo is in the mortar joints. The size of steel necessary is less than the thickness of the mortar joint; therefore, it does not interfere with the laying of the blocks and, by placing it in the mortar joint, it is thoroughly protected from rust. The amount of steel necessary is shown in figure 6, and the size of wire most suitable will vary with the size of the silo and its availability. Heavy wires are not generally carried in stock, therefore a decision in regard to the size to be used should be made and the order placed at least a month before building. It is hoped that the demand will cause manufacturers to carry a sufficient supply to be able promptly to furnish silo builders with material. The size of the wire most convenient to use is No. 3, which is $\frac{1}{4}$ inch in diameter. This is as large as can be handled in the mortar joints conveniently, but it is not larger than necessary. Even with this size of wire it is necessary in the case of large silos, and 8-inch blocks, to place more than one wire in each mortar joint near the bottom. However, if convenient to purchase, it will sometimes be advan-

tageous to purchase No. 6, 8, or 9 wire for the upper portion of the silo where less reinforcement is necessary. The wire, when embedded in the mortar, will not rust, therefore black wire should be used as it is cheaper than galvanized. All wire should be stored in a dry place where it will not rust. The most desirable quality is hard or high-carbon wire. Soft or medium wire is difficult to straighten and kinks badly in handling, thus causing considerable trouble. Hard or high-carbon wire is as cheap as any, more convenient, and stronger. These heavy wires are wound in coils, therefore it becomes a very important problem to straighten them sufficiently to lay on the wall.

In figure 6 is shown the number of wires No. 9 or No. 3 which should be placed in each mortar joint of any silo varying in diameter from 12 to 20 feet and 40 feet or less in height, with mortar joints 5 and 8 inches apart. The left half of the plate is for mortar joints placed 8 inches apart while the right half is for joints 5 inches apart. Most standard material is such as to be laid in one of these two ways. The top row of figures on either side of the plate indicates diameters. The left figure of the double column below each large figure indicates the number of No. 9 wires while the right of the double column indicates the number of No. 3 wires for each joint. The distance from top of silo should be the basis of calculation at all times.

In practice, the table would be used as follows: For example, take a 16 by 36 silo made of 4 by 8 by 12 blocks, reinforced with No. 3 wire. In the left half of the table under 16 at a depth of 36 feet is found mortar joint No. 54 which should contain two No. 3 wires. Succeeding joints should be reinforced as indicated in this column successively above.

The most convenient method tried for straightening this wire * * * may be described as follows: Secure or build a reel from which a coil of wire may be conveniently unwound. Mount this reel upon a plank or platform where it will turn easily, then secure a short piece of gas pipe close to the reel as shown in figure 7.

Through this pipe draw the wire as it uncoils from the reel. The pipe should be so placed that its curvature will be the reverse of the curvature of the wire in the coil. At a convenient distance from the pipe, drive a stake, at which point the wires may be cut to their proper length. In order to determine this length easily, another stake may be driven to which the end of the wire may be pulled each time before cutting. As soon as the first wire is cut, it should be laid upon the wall or fitted to a similar sized circle to see if the curvature is correct. If not, the curvature of the pipe may be altered and, by a few trials, the proper curvature secured.

The horizontal or bed joints should be thoroughly bedded to cover the steel reinforcement. The vertical joints at the block ends should be made with extreme care in order to insure perfect air and water-tight joints. In order to do this the ends of both blocks should be mortared before pressing together. * * *

The outside joints should, for the sake of appearance, be struck neatly with the trowel as the work progresses, and for warmth they should of course all be tight. On the inside, however, this is scarcely sufficient, as there might still be an occasional opening left between the ends of the blocks, which would permit the air to enter. In order to close all such openings, the mortar may be left hanging on the inside or cut roughly, then while still green washed with a cement wash before the scaffold is raised or the work left for the night. This wash naturally brings to view any crevices which may exist. These may then be filled with mortar, and this thoroughly seals the inside of the wall. This wash is composed of cement and water mixed to about the consistency of good paint and can be applied with a broom. The wash should be applied vigorously in order to smooth down and fill the irregularities.

The blocks should be carefully examined as to quality, and "only unquestionably good blocks should be put in the ground or near the grade line."

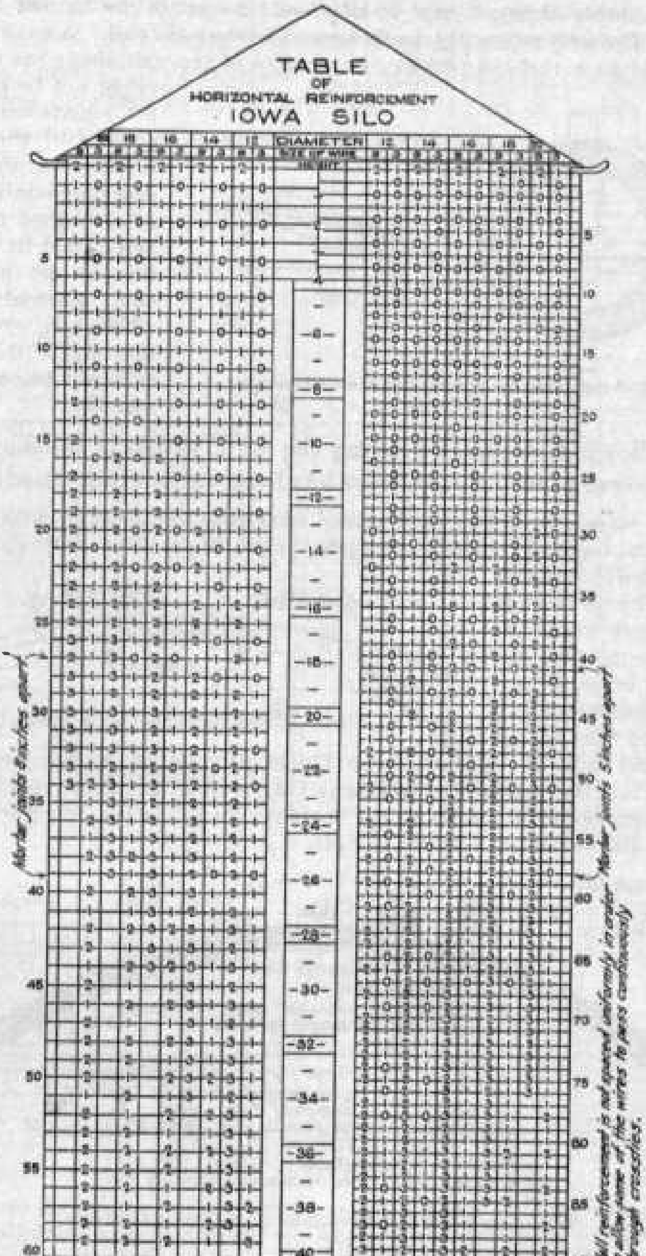

FIG. 6.—Diagram showing number of strands of wire reinforcement for each mortar joint.

All questionable blocks, if used at all, should be put in the top few feet of the structuro. The modium quality should be used for the main wall. A quality of block which would be entiroly satisfactory for portions of the wall abovo the foundation might not be permissible for foundation work on account of the moisture present on the outside near the grade line. However, it must be remembered that it is always best to get unquestionable material for the wholo silo oven though the cost of the material or freight bo considerably more.

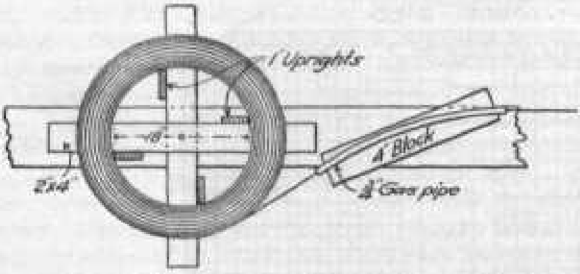

FIG. 7.—Reel and device for straightening wire reinforcement.

The following method of laying the wall, which is considered only one of several practical methods, has been successfully used:

Tho first course should be spaced around one-eighth to three-sixteenths of an inch apart without mortar in order to determine the proper diameter of silo and length of guido. This will overcome tho necessity of cutting blocks. Steel should be placod upon the outer half of courses in order that thero shall be enough mortar inside to bear against tho wiro and hold the blocks. Loose blocks may bo placed temporarily upon the wall to hold the steel in place at intervals of 6 or 8 feet as occasion requires. Steel upon tho courses below and above the doorways should be long enough to lap past each other and be hooked as shown in figure 8.

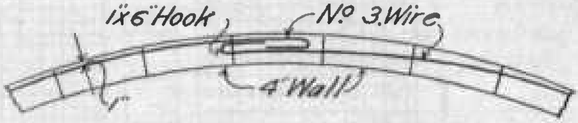

FIG. 8.—Method of lapping wall reinforcement.

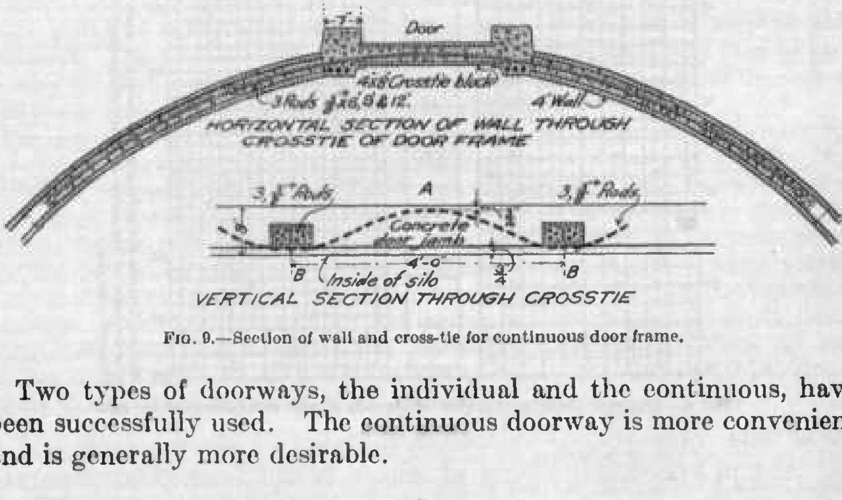

FIG. 9.—Section of wall and cross-tie for continuous door frame.

Two types of doorways, the individual and the continuous, have been successfully used. The continuous doorway is more convenient and is generally more desirable.

In the individual doorway the size of opening is 32 inches wide by 34 to 36 inches high, depending somewhat upon the size of the blocks, of which three or four courses are placed between the doors. The continuous doorway is 22 inches wide by 40 to 48 inches high. It consists essentially of a continuous door jam on each side of the opening.

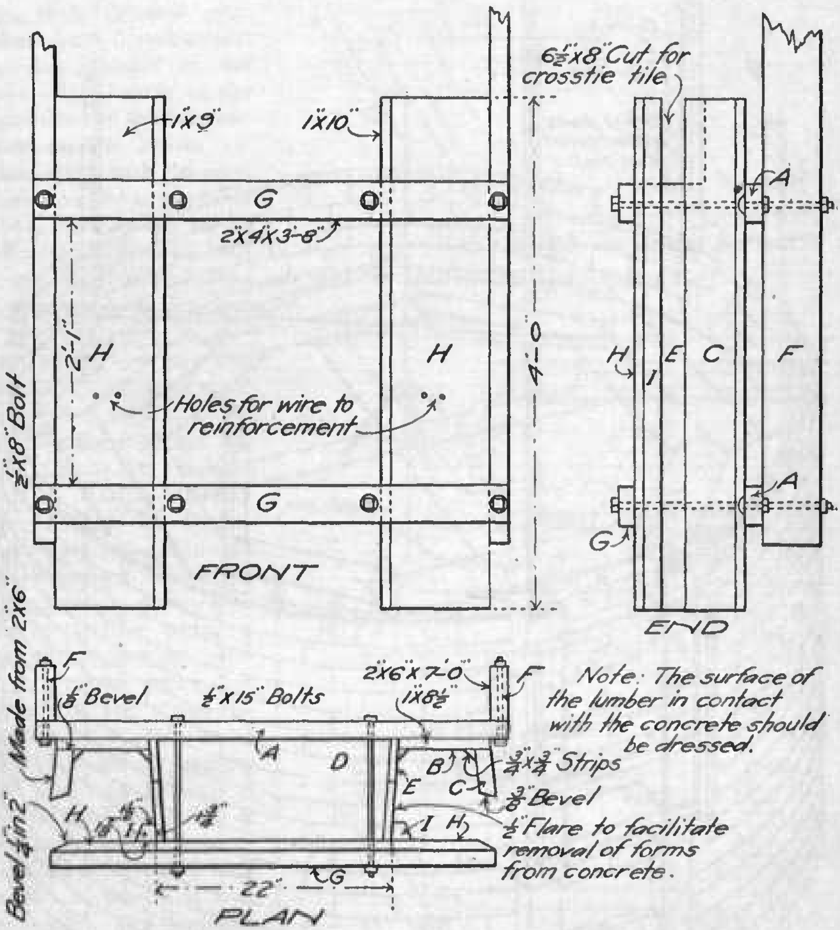

Fig. 10.—Forms for continuous concrete door frame.

These jams are made up of reinforced concrete. The horizontal reinforcements of the silo wall hook into the vertical reinforcements of the jam. The jams are tied together at intervals of 4 or 5 feet by steel within the crosstie blocks. This steel not only extends into the vortical jam, but in order to be more secure, extends several feet into the wall on either side of the jam.

These crossties may be built, as shown in figure 9, of steel protected from rust by being incased within the clay blocks filled with concrete or concrete alone.

A detailed drawing of the form used for the continuous doors is given in figure 10. The form, scaffold, and guide used in building the silo wall and doorway are shown in place in figure 11.

The doors to fit the individual doorway must be curved and may be made as shown in the drawing, figure 12. Two cleats may be sawed to the proper curve and two

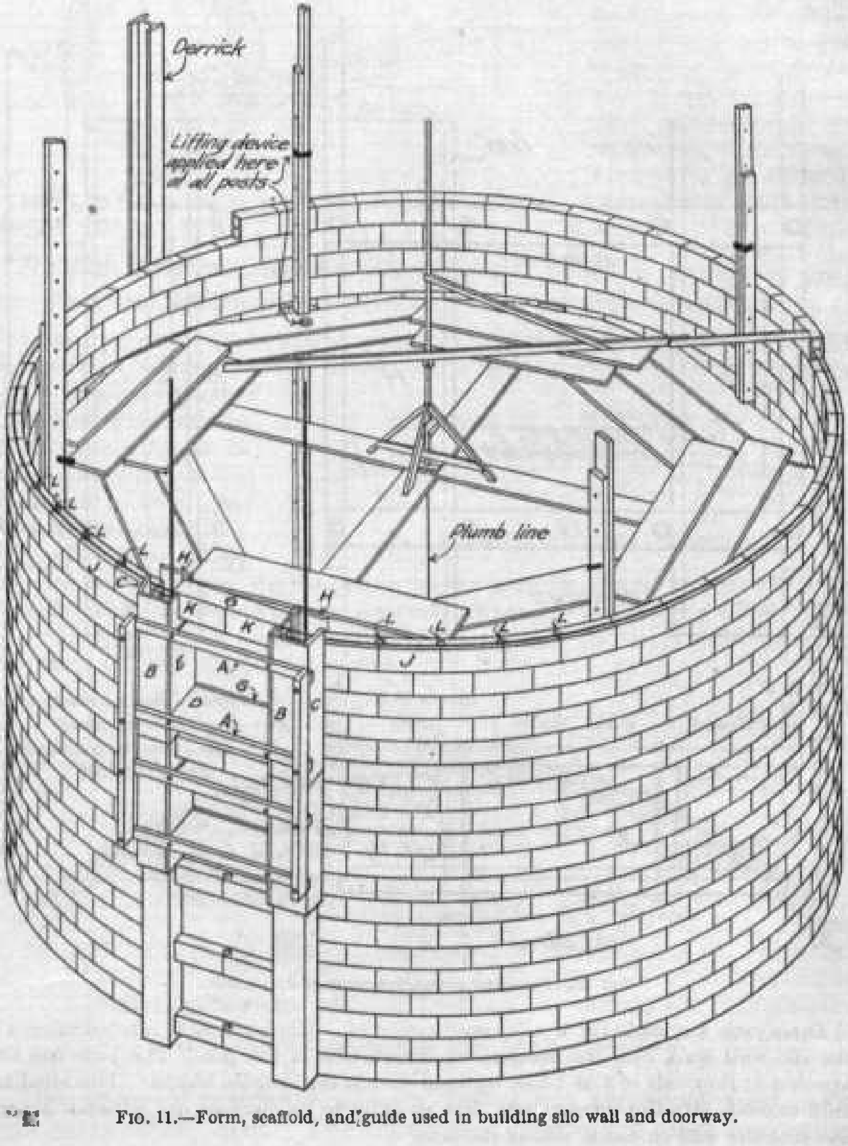

FIG. 11.—Form, scaffold, and guide used in building silo wall and doorway.

thicknesses of 6-inch fence flooring nailed to the inner side of the curve, between which should be placed a layer of tar paper. The cleats should not reach closer than within 1½ inches of side of the door, as a 1½ inch bearing will be necessary between the door and the concrete door frame.

Two principal kinds of doors have been successfully used in the continuous doorway. Figure 13 shows a door made of two thicknesses of fence flooring crossed with tar paper between. These doors are beveled at the end to set loosely into the beveled shoulder in the concrete.

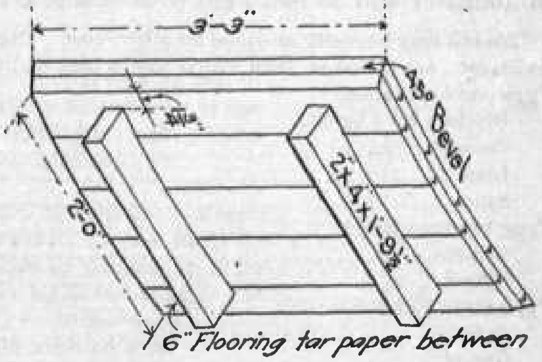

FIG. 12.—A form of individual door.

A cheaper and very good door is shown in figure 14. This door as shown is made of two thicknesses of ship-lap, that lap onto each other about 2 inches and are not beveled at the ends. The boards on the outer side are shorter than those on the inside. A wide cleat with beveled edges is nailed to the inner side of the door and on the different doors meet end to end, thus offering little obstruction to the free settling of the silage.

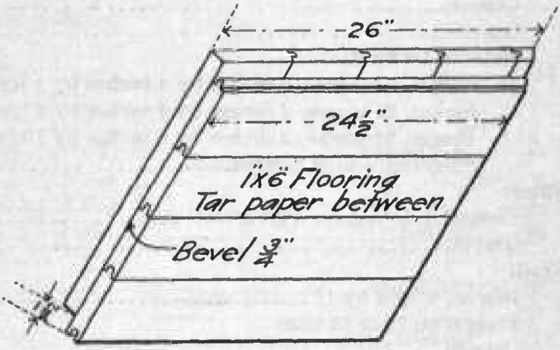

FIG. 13.—A form of continuous door.

In order that any silo may fulfill its purpose, it is necessary that the joints between the doors and the door frames be air-tight. * * * Sealing with clay was found to be satisfactory where reasonable care was exercised in its use. This becomes a very simple matter by taking a quantity of fine clay, wetting it until sticky but quite stiff, and filling the shoulder of the door frame with this before pressing the door into place. If the mud is rather stiff it will hold the door to place until the silage is up high enough to secure it permanently. The moisture of the silage keeps the clay damp on the inside, thus making it air-tight.

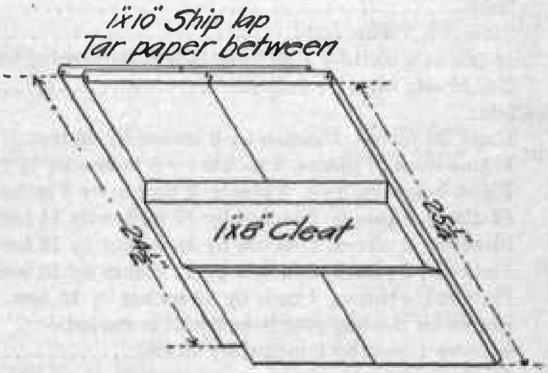

FIG. 14.—A cheaper form of continuous door.

While a roof is not absolutely necessary, it is desirable for a number of reasons. It may be built of concrete, wood, metal, or other material, but concrete construction presents certain decided advantages and insures a building constructed throughout of equally dura-

ble material. A convenient method of constructing a concrete roof is described in detail.

The following is a bill of materials required for an Iowa silo 16 feet in diameter and 35 feet high with concrete roof:

This bill may be easily modified for other sizes. The different types of foundations, doors, etc., are included, from which choice may be made to suit condition.

Type one foundation:		
Blocks 4 by 8 by 12		130
Cement	sacks	1½
Lime	do	1½
Sand	yard	$\frac{2}{9}$
Type two foundation:		
Cement	barrels	2½
Gravel	yards	2
Type three foundation:		
Cement	barrels	5¾
Gravel	yards	4½
Type four foundation:		
Cement	barrels	6½
Gravel	yards	5
Material for forms—		
Stakes, 24 pieces, 2 inches by 4 inches by 6 feet	board feet	98
Stakes, 24 pieces, 2 inches by 4 inches by 2 feet	do	32
Braces, 24 pieces, 2 inches by 4 inches by 10 feet	do	160
Sheeting, ½-inch lumber	do	300
Floor:		
Cement	yards	2
Gravel	barrels	2½
Wall:		
Blocks, 4 by 8 by 12		[a] 3,000
Freight on 18 to 24 tons.		
Cement	barrels	5
Lime	do	5
Sand	yards	2
Steel No. 3 wire, hard	pounds	400
18 pieces ½ inch by ½ inch by 18 feet reinforcing bars	do	276
No. 12 soft wire	do	5
Scaffold:		
Posts, 20 pieces, 2 inches by 6 inches by 16 feet	board feet	320
Frame work, 5 pieces, 2 inches by 8 inches by 12 feet	do	80
Plank below scaffold, 2 pieces, 2 inches by 8 inches by 16 feet	do	44
Platform, 2 pieces, 2 inches by 12 inches by 14 feet	do	56
Platform, 2 pieces, 2 inches by 10 inches by 16 feet	do	54
Platform, 6 pieces, 2 inches by 12 inches by 16 feet	do	192
Platform, 4 pieces, 1 inch by 12 inches by 16 feet	do	64
Braces for holding post before wall is started—		
8 pieces 1 inch by 6 inches by 16 feet	do	64
4 wire stretchers.		
4 clevises.		

[a] In case type 4 foundation is used, the number of blocks will be about 150 to 200 less.

Forms:		
Individual door form—		
Lumber, 2 pieces, 2 inches by 6 inches by 10 feet	board	20
Lumber, 1 piece, 2 inches by 6 inches by 16 feet	do	16
Lumber, 1 piece, 2 inches by 4 inches by 14 feet.		
Lumber, 2 pieces, 2 inches by 4 inches by 12 feet	do	25
Lumber, 4 pieces, 1 inch by 10 inches by 14 feet.		
Lumber, 1 piece, 1 inch by 10 inches by 14 feet.		
Lumber, 2 pieces, 1 inch by 10 inches by 16 feet	do	88
Eight ½ inch by 10 inches machine bolts.		
Eight ½ inch by 17 inches machine bolts.		
Continuous door forms—		
Lumber, 1 piece, 2 inches by 4 inches by 8 feet.		
Lumber, 2 pieces, 2 inches by 4 inches by 14 feet	do	24
Lumber, 2 pieces, 2 inches by 6 inches by 16 feet	do	32
Lumber, 4 pieces, 1 inch by 10 inches by 14 feet	do	47
Lumber, 1 piece, 1 inch by 10 inches by 8 feet	do	7
Eight ½ inch by 7 inches machine bolts.		
Eight ½ inch by 15 inches machine bolts.		
Guide:		
¾ inch by 1½ inches by 14 feet stop.		
2 pieces 4 feet lath.		
2 inches by 4 inches by 8 feet	feet	5⅓
8 feet gas pipe 3 inches or 1 inch.		
Derrick:		
3 pieces 2 inches by 6 inches by 16 feet	board feet	48
1 piece 2 inches by 6 inches by 6 feet	do	6
6 pieces 1 inch by 6 inches by 16 feet	do	48
3 guy wires (100 feet each) No. 9 wire	pounds	20
Individual doors (six are required):		
Fence flooring	board feet	96
2 by 4 cleats	do	16
Tar paper or prepared roofing	square yards	6
8d nails.		
Continuous doors:		
Fence flooring	board feet	152
Tar paper or prepared roofing	square yards	10
6d nails.		
Continuous doors:		
10 inch shiplap	board feet	172
Tar paper or prepared roofing	square yards	10
6d nails.		
Roof:		
Cornice blocks—		
Cement	barrels	1½
Sand	cubic yards	¾
Steel No. 9 wire	pounds	10
Form for cornice blocks—		
1 piece 1 inch by 8 inches by 3½ feet; 1 piece 1 inch by 6 inches by 12 feet	board feet	8¼
1 piece 2 inches by 4 inches by 7 feet	board feet	5
Lever for setting—		
1 piece 2 inches by 4 inches by 8 feet	board feet	5⅓

Roof—Continued.

Cement	barrels..	5
Gravel	yards..	2
Steel, 3 pieces ½ inch by ½ inch by 18 feet	pounds..	46

False work:

26 pieces 1 inch by 12 inches by 10 feet sheeting	board feet..	260
8 pieces 2 inches by 6 inches by 10 feet rafters	do....	80
1 piece 4 inches by 4 inches by 6 feet or 1 cedar post	do....	8
5 pieces 1 inch by 8 inches by 16 feet	do....	54
4 pieces 1 inch by 6 inches by 16 feet	do....	32
8 forgings.		

The following estimate of labor required for the construction of an Iowa silo "is based upon the use of 4 by 8 by 12 curved blocks, and a silo 16 feet diameter and 35 feet high with concrete roof. By modifying this estimate to suit any other size of silo or local labor conditions, a quite definite idea of labor cost may be obtained."

Excavation:
- 4 men 5 hours.
- 1 team 5 hours.

Footing:
- Type one—
  - Mason 3 hours.
  - Mason helper 3 hours.
  - Unskilled labor 3 hours.
- Type two—
  - Mason 4 hours.
  - Mason helper 4 hours.
  - Unskilled labor 4 hours.
- Type three—
  - Mason 6 hours.
  - Mason helpor 6 hours.
  - Unskilled labor 6 hours.
- Type four—
  - Labor on concrete and forms.
  - Mason 15 hours.
  - Mason helper 15 hours.
  - Two unskilled laborers 15 hours each.

Floor:
- Mason 5 hours.
- Mason helpor 5 hours.
- Two unskilled laborers 5 hours each.

Individual door forms: Carpenter 20 hours.

Continuous door forms: Carpenter 15 hours.

Scaffold:
- Carpenter 10 hours.
- Unskilled laborer 10 hours.

Wall:
- Mason 60 hours.
- Mason helper 60 hours.
- Two unskilled laborers 60 hours each.

Doors:
- Individual type: Carpenter 6 hours.
- Continuous type: Carpenter 5 hours.
- Continuous type: Carponter 3 hours.

Roof:
- Cornice blocks making—
  - Mason 5 hours.
  - Mason helper 5 hours.
  - Unskilled laborer 5 hours.
- Cornice block setting—
  - Mason 6 hours.
  - Mason helper 6 hours.
  - Two unskilled laborers 6 hours each.
- Framing false work: Carpenter 6 hours.
- Placing false work—
  - Mason 3 hours.
  - Mason helpor 3 hours.
  - Two unskilled laborers 4 hours each.
- Placing concrete—
  - Mason 8 hours.
  - Mason helper 8 hours.
  - Two unskilled laborers 8 hours each.
- Removal of false work and scaffold: Three unskilled laborers 6 hours each.

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